Annual Report to NOAA Climate Program Office, Climate and Societal Interactions, Regional Integrated Science and Assessment

Award Title: Alaska Center for Climate Assessment and Policy

Performance Period: June 1, 2014 – May 31, 2015

This performance period covers the fourth year of Award NA11OAR4310141. In this reporting period the ACCAP office moved into renovated space located within our administrative home, the International Arctic Research Center (IARC), at the Syun-Ichi Akasofu Building on the University of Alaska Fairbanks (UAF) campus.

Team Members:
Principal Investigator: Sarah F. Trainor
Co-Investigators: John Walsh, Jeremy Mathis, and T. Scott Rupp
Coastal and Living Marine Research Specialist: Philip Loring
Research Associates: Corrine Knapp, Casey Brown
Program Manager: Tina Buxbaum
Post-Doctoral Fellows: Peter Bieniek, Nathan Kettle
Graduate Students: Lauren Frisch, Henry Penn, Katia Kontar*, Rick Lader*
*Starting May 2015

ACCAP Steering Committee:
Ex Officio Members
Dan White (resigned Jan 2015)*, former ACCAP PI and Director, *Institute of Northern Engineering, UAF*
Molly McCammon, Director, *Alaska Ocean Observing System*
James Partain, *NOAA Regional Climate Services Director, Alaska Region*
Aimee Devaris, Director, *NOAA National Weather Service, Alaska Region*
Amy Holman, Coordinator, *NOAA Regional Collaboration Team, Alaska Region*
Stephen Gray, Director, *DOI Alaska Climate Science Center*

Members-At-Large
Lawson Brigham, Professor of *Geography & Arctic Policy, UAF*
Vera Metcalf, Director, *Alaska Eskimo Walrus Commission, Kawerak Inc*.
Cheryl Rosa, Deputy Director, *U.S. Arctic Research Commission*
Gunner Knapp, Director and Professor of Economics, *Institute of Social and Economic Research, University of Alaska Anchorage*
Greg Balogh (resigned Oct 2014)*, *Arctic Landscape Conservation Cooperative, US Fish and Wildlife Service*
* To be replaced as per Steering Committee Recommendation

Report Contents

1. NEW AREAS OF FOCUS AND PARTNERSHIPS

In our research, decision-support tool development, and outreach, ACCAP has established new stakeholder partnerships including expanded collaborations with NOAA and non-NOAA federal agencies. We have also expanded our research efforts in climate science, boundary science, and adaptation planning. Existing strengths remain in coastal and living marine resources, and sea ice and cryosphere hazards. ACCAP partners are highlighted in bold throughout the report.

A. Expanded Federal Office and Agency Collaborations

1. U.S. Fish and Wildlife Service, Western Alaska Landscape Conservation Cooperative (WALCC).

ACCAP partnered with **WALCC** to identify and synthesize existing research projects in the **WALCC** region related to physical, biological and human dimensions of coastal change. This project documents the research landscape for communities facing change, decision-makers navigating change, researchers pursuing projects, as well as funding agencies trying to prioritize where to allocate resources. The final project report and database spreadsheet were delivered in May 2015 and are available on the ACCAP website. A final project webinar occurred on June 10, 2015. We plan to continue to update the Western Alaska LCC project report and database. More information available in section 5.A. or https://accap.uaf.edu/W_AK_LCC_Coastal_Change_Research.

Additionally, we are in discussion with the **North Pacific Landscape Conservation Cooperative (NPLCC)** to expand this effort to southern geographies including Cook Inlet, Southeast Alaska and British Columbia. The goals of this extension are to:

> *Long term:* (1) to foster better trans-boundary coordination about coastal change research in Cook Inlet and South East Alaska, (2) help practitioners and scholars learn from one another, and (3) identify research gaps that need to be addressed.
>
> *Short term:* (1) to create a coastal change database that compiles current coastal change research occurring in Cook Inlet and South East Alaska, (2) to produce an inviting, accessible report that compiles current coastal change research occurring in the NPLCC, and (3) update existing coastal change project resources for the Western AK LCC.

2. Collaboration with National Weather Service (NWS)

ACCAP and the **NWS Alaska Region** have a mutually beneficial relationship that enhances the reach and compliments the mission of both organizations. ACCAP has access to real-time, high-quality information, while NWS leverages ACCAP's outreach capabilities, reputation and network of stakeholders. The collaboration allows for greater credibility and salience across organizations and advance the vision and mission to help Alaskan's adapt to a changing climate and to promote a weather ready nation. This collaboration has grown over the course of ACCAP's existence and this reporting period and continues to build on capacities of both organizations and be a valuable partnership for ACCAP. Highlights are listed in roughly chronological order from initial inception. All activities are ongoing and ACCAP and NWS continue to build and enhance this highly productive collaboration.

ACCAP/ NWS Collaboration Highlights:

Climate and Weather Highlights Tool

Designed to provide information about notable weather and climate events. Data reported are preliminary observations and are reported in daily, multi-day, monthly, and longer time scales. Users can select date ranges, filter results, click on individual events for further information, and zoom in/out of the map. Events are added/updated in near real-time. Rick Thoman of the NWS provides the data for this tool and ACCAP provides the online interface that allows stakeholders to access the highlights in a visually appealing and easy to understand manner (https://accap.uaf.edu/?q=tools/climate_highlights).

Alaska Climate Dispatch Newsletter

Published quarterly and written for a non-technical audience, the Dispatch features seasonal weather and climate summaries, articles on topics of current interest, as well as weather, wildlife, and sea ice outlooks (https://accap.uaf.edu/library/dispatches, see section 3 and appendix 2).

NWS Quarterly Climate Impacts and Outlook Graphics

As an outgrowth of the collaboration initiated from the Highlights tool and the Dispatch, ACCAP provides the NOAA Alaska Regional Climate Services Director with graphics for the quarterly NWS Climate Impacts and Outlook document. NWS again provides the data for the graphics and ACCAP provides professional graphic design for the figures features in the final print product (http://www.drought.gov/drought/content/resources/reports).

NOAA Ernest F. Hollings Scholar

ACCAP (Walsh), in partnership with the **National Weather Service** (Rick Thoman) hosted a NOAA Ernest F. Hollings scholarship intern (Lauren Zuromski) during the summer of 2014. Using a database of storm and other extreme weather and climate events, she compiled a catalog of impacts and determined the linkages between extreme events and impacts for six significant weather and climate events. Zuromski delivered both an ACCAP Alaska Climate webinar and a presentation at the Hollings Scholar Symposium in Silver Springs, MD upon completion of her project in August 2014 (https://accap.uaf.edu/Hollings_extreme_events). Additionally, Lauren presented a poster on this effort at the 2014 American Geophysical Union fall meeting in San Francisco, CA (see section 2.A).

NWS Alaska Climate Forecast Briefings

Beginning in July 2014 ACCAP partnered with Rick Thoman, the Alaska Climate Science and Services Manager, **National Weather Service (NWS)** to deliver monthly climate forecast briefings. These briefings present recent climate conditions around Alaska and the predictions for the next month and season. The briefings occur monthly and are accessible both in-person and virtually via the ACCAP webinar interface. Briefings have been well attended with 5-15 people in-person and approximately the same number online. This collaboration stemmed from several very successful Alaska Climate Webinar series presentations indicating there was an interested in monthly climate briefings (see section 3). Additionally, Rick Thoman presents similar information internally to the NWS the Thursday before the Briefings and is thus able to draw on products already being produced to present the Briefings. This collaboration is also helping to foster closer connections between NWS and the UAF research community (https://accap.uaf.edu/NWS_Briefings).

Climate Divisions to Construct Anomalies and Trends in Alaska

ACCAP/NWS partnered with NOAA Alaska Regional Climate Services Director and the University of Alaska Fairbanks to construct and use Alaska climate divisions as the basis for an assessment of Alaska temperature and precipitation trends (https://accap.uaf.edu/project/using-climate-divisions-construct-anomalies-and-trends-alaska, see section 5.B.)

3. Scenario Planning for Energy and Resource Development on the North Slope, Alaska. ACCAP partnered with the **Geophysical Institute** at UAF and **GeoAdaptive**, a research consultancy with worldwide expertise in the development of complex spatial and participatory scenarios processes on a project commissioned by the **North Slope Science Initiative (NSSI).** NSSI is an intergovernmental effort to increase collaboration at the local, state, and federal levels to address the research, inventory, and monitoring needs as they relate to development activities on the North Slope of Alaska. NSSI partners include The **Bureau of Land Management, US Fish and Wildlife Service, National Park Service, National Marine Fisheries Service, Bureau of Ocean Energy Management, AK Department of Natural Resources, AK Department of Fish and Game, Arctic Slope Regional Corporation, North Slope Borough,** and the **Bureau of Safety and Environmental Enforcement**. ACCAP is providing logistic and outreach support including preparatory open web-based meetings hosted and archived by ACCAP. ACCAP also hosts a project page within the ACCAP website that contains all pertinent documents and information about this project (available at https://accap.uaf.edu/Scenario_planning_NSSI).

B. Sea Ice

Expansion of the Historical Sea Ice Atlas for Alaska Waters. In partnership with **Alaska Ocean Observing System (AOOS),** the **National Weather Service Anchorage Office Sea Ice Desk,** the **National Snow and Ice Data Center (NSDIC), NOAA's Pacific Environmental Marine Laboratory (PMEL), the University of Illinois,** and the UAF **Scenarios Network for Alaska and Arctic Planning (SNAP),** ACCAP continues to update the Historical Sea Ice Atlas for Alaska Waters, the first gridded, digitized record of historical sea ice concentrations in offshore Alaska. ACCAP and AOOS are currently exploring the inclusion of sea ice information from Royal Dutch Shell Corporation into the digital atlas. Extension of digital sea ice database to

pan-Arctic region has been undertaken in partnership with National Snow and Ice Data Center; primary users to date are NOAA Earth System Research Laboratory's 20th-Century Reanalysis project team and Hadley Centre's (U.K.) climate modeling group. The Historical Atlas for Alaska Waters is accessible at http://seaiceatlas.snap.uaf.edu/ (further details are presented in sections 2.B).

C. Climate Science

1. Dynamical Downscaling for Alaska.

In partnership with the DOI **Alaska Climate Science Center and the UAF Department of Atmospheric Sciences** (U. Bhatt), ACCAP continues its dynamical downscaling work for Alaska. This project is making use of the WRF regional climate model, forced by two global climate models (GFDL and CCSM4) and two different RCP forcing scenarios through 2100. The forcing scenarios are the same ones used in our statistical downscaling. Hindcasts for the post-1979 period are complete, and the 21st-Century simulations are underway. Dynamical downscaling output will enable extension of studies of extreme events over Alaska to include new variables such as snow, wind, soil moisture, and humidity. Findings reported in section 2.A.

2. Extreme events in high latitudes

Building on previous ACCAP work including the dynamical downscaling work with the DOI **Alaska Climate Science Center** ACCAP has begun several projects focused on extreme events in high latitudes. Understanding past extreme events, both the cause and effects, and the future projects of extreme events in Alaska are of great interest and importance for future adaptation measures.

In partnership with the DOI **Alaska Climate Science Center,** extreme events assessment in dynamical downscaling output for Alaska, based on regional climate model simulations, is the Ph.D. thesis research topic of R. Lader beginning in May 2015. The dynamical downscaling (historical and future simulations) makes available a full suite of model variables, allowing broad expansion of extreme events analysis for Alaska, e.g., inclusion of snow, wind, icing events. ACCAP and the **Alaska Climate Science Center** are providing Lader's graduate research assistantship.

D. Student and Minigrant Funding

1. Improve Preparedness and Response to Annual Springtime Flooding in Alaska and Yakutia.

In May of 2015 ACCAP began funding PhD student Katia Kontar in her interdisciplinary project to foster socioeconomic wellbeing in the US and Russian communities of the North through the development of effective ice jam and flood mitigation and disaster response and recovery strategies.

In Alaska, US and Yakutia (Sakha Republic), Russia, spring is known as a flood season. Rapid warming can force river ice to break up quickly and pile in tremendous jams at narrow and curved points of the rivers, flooding nearby settlements. Significant funds are spent on annual disaster response and recovery efforts. In addition to the financial losses, spring floods lead to injuries and loss of life, displacement and long-term evacuation of population, damage to cultural

or heritage sites, loss of means of livelihood, and ecosystem resource loss. The main goal of Kontar's PhD research is to improve preparedness and response to annual springtime flooding in Alaska and Yakutia through the development of effective and easily adaptable flood risk mitigation and disaster response and recovery strategies. Her research is based on comparative analysis of the flood sites Galena, Alaska and Edeytsy, Yakutia, Russia, which both suffered devastating floods in May 2013 (https://accap.uaf.edu/ice_jams_alaska_siberia).

2. ACCAP Minigrant Competition

In the spring of 2015 ACCAP solicited proposals as part of a minigrant competition. Proposals were for salary support for one month of summer faculty support or three months of summer graduate student support. We funded a total of six projects which all began in May of 2015. Final project reports are due in September of 2015. The projects cover the full breadth of ACCAP foci and all have a significant stakeholder engagement component aimed at promoting use-inspired science. The projects include:

a. Informing Fisheries Adaptations to a Changing

Terry Johnson, Alaska Sea Grant Marine Advisory Program

Goal: to provide the public and concerned stakeholders the information on the effects and potential adaptations to climate change and ocean acidification that they need to influence policy, develop technologies, and change behaviors.

b. Improving understanding of ringed and spotted seal sea ice habitat for resource managers

Olivia Lee, University of Alaska Fairbanks (IARC)

Goals: To improve partnerships between cryosphere researchers, resource managers, and local stakeholders to better understand data products of greatest use to resource managers and subsistence hunters, and to improve the understanding of sea ice habitat use for ringed and spotted seals.

c. Improving scientific understanding of the changing hydrologic system of the Jarvis Creek watershed and its impacts on the ecosystem

Anna Liljedahl, Water and Environmental Research Center & International Arctic Research Center, University of Alaska Fairbanks

Goal: to develop a comprehensive understanding of how recent and projected climate warming have and will affect glaciers and permafrost and its cascading effects on the larger-scale hydrologic system of Interior Alaska.

d. Blue carbon: the role of marine predators in carbon storage and sequestration

Heidi Pearson, Assistant Professor of Marine Biology, Department of Natural Sciences, University of Alaska Southeast

Goal: To determine the capacity for marine mammals to sequester carbon in Southeast Alaska via whale pump and trophic cascade carbon processes.

e. Climate-induced changes to trophic interactions of top predators and forage fish species in a sub-Arctic ecosystem

Courtney Pegus, School of Fisheries and Ocean Sciences, University of Alaska Fairbanks

Goal: To develop a productive research-oriented working relationship with the National Park Service that will be mutually beneficial for the research objectives of this study as well as the long-term monitoring efforts of the NPS. The specific research objectives are to determine if climate-driven changes to glacial ice are related to declines in harbor seal populations in Glacier Bay and to investigate the possibility of inter-specific competition

occurring between harbor seals and humpback whales because of reduced glacial ice habitats.

f. Sustainable Engineering Techniques for Rural and Traditional Arctic Infrastructure

Rorik Peterson, Institute of Northern Engineering, University of Alaska Fairbanks

Goals: Stemming from previous work in the Arctic coastal community of Kaktovik, to perform high-resolution numerical modeling of this community's ice cellar in in order to provide guidance for future monitoring and design, and to use the existing numerical model to identify the impact of different food storage techniques. Additionally, on a broad scale, to identify new hydrothermal infrastructure challenges that can be addressed using novel engineering solutions that utilize sustainable techniques.

3. Center for Global Change Student Grant Competition

ACCAP (Walsh) served on the review team that reviewed for the 2015 **Center for Global Change (CGC)** student grant competition at the **University of Alaska Fairbanks**. CGC annually funds students through a variety of sources and funding agencies (federal and state) as well as University of Alaska general funds. ACCAP agreed to provide funding for two CGC student projects. The two projects align with the greater ACCAP mission and foci. One project is focused on the subsistence halibut fishery in SE Alaska. It will assess long-term trends in subsistence halibut harvest and evaluate the mechanisms driving changes in harvest. The other project investigates the morphology of the Beaufort Sea coastline during the last interglacial period as a potential historical analog for predicted future sea level change. Those projects will begin in July of 2015 and continue through the 2015/2016 academic year.

E. Coastal and Living Marine Resources:

Ocean Acidification in Alaska Workshop

In December of 2014, ACCAP partnered with AOOS (Alaska Ocean Observing System) to conduct a 1-day ocean acidification workshop. Over 100 interested citizens, stakeholders and experts came together in Anchorage on Dec 2, 2014 to discuss ocean acidification (OA) and the latest research, policy implications, community perspectives, and potential impacts to Alaska. Another 70 people joined by webinar individually or from satellite stations hosted in Craig, Fairbanks, Homer, Seward and Unalaska. Workshop agenda, presentations, and recordings are all available here: http://www.aoos.org/ocean-acidification-workshop/.

A smaller group of about 30 stakeholders convened the following day, December 3, to define statewide needs for OA monitoring, research, education and outreach within Alaska. The discussion led to a draft Call to Action and a collaborative strategy to:

- Continue basic operations and maintenance of the existing OA buoy network
- Support additional research on biological and community impacts
- Provide stakeholder and community engagement, potentially through a Blue Ribbon Panel

2. KEY RESEARCH FINDINGS AND OUTREACH ACTIVITIES

We report our core research findings and outreach activities based on the major areas of focus at ACCAP: climate science, sea ice, adaptation and boundary science, and coastal and living marine resources.

A. Climate Science

1. Extreme events in high latitudes

Building on previous ACCAP work including the dynamical downscaling work with the DOI **Alaska Climate Science Center** and incorporating the work of the **NOAA Hollings Scholar** ACCAP has begun several projects focus on extreme events in high latitudes. Understanding past extreme events, both the cause and effects, and the future projections of extreme events in Alaska are of great interest and importance for future adaptation and mitigation actions.

Key Research Findings:

- Frequencies of extreme high temperatures and heavy precipitation events show increases over the past three decades in most atmospheric reanalysis (Lader et al., 2015), and these events are projected by global climate models to increase significantly over Alaska through the 21st Century (Bennett and Walsh, 2014). Extreme low temperatures are projected to decrease.
- Two state-of-the art global climate models project increases in storm intensity in much of the Arctic including Alaska. Overall storm frequency-of-occurrence in the Arctic show little projected trend, although the retreat of sea ice means more storms will impact Alaskan coasts with open water. These future changes would continue the ongoing pattern of change that has been detected over the extratropical Northern Hemisphere
- Studies of linkages between the Arctic and mid-latitude extreme weather showed that (1) extreme cold airmasses originating in northern Canada have moderated over the past five decades, and (2) the recent extreme cold winters in the northern and eastern United States are not unprecedented in the past 50 years. The link between Arctic sea ice loss and mid-latitude weather remains speculative
- There is also suggestive evidence of an increase in extreme winds (at least annually) over parts of the ocean since the early to mid-1980s, but the evidence over the U.S. land surface is inconclusive. Finally, there is moderate evidence of an increase in extreme waves in winter along the Pacific coast since the 1950s, but along other U.S. shorelines any tendencies are of modest magnitude compared with historical variability.

Key accomplishments:

- Using a database of storm and other extreme weather and climate events, ***NOAA Ernest F. Hollings Scholar***, Lauren Zuromski compiled a catalog of impacts and documented the linkages between extreme events and impacts for six different weather and climate events in Alaska (https://accap.uaf.edu/Hollings_extreme_events, see section 1.A. for more details)

Key outreach activities/presentations

- The NOAA Hollings Scholar delivered both an ACCAP Alaska Climate webinar and a presentation at the Hollings Scholar Symposium in Silver Springs, MD upon the completion of her project in August 2014. Additionally, Zuromski presented a poster on this effort at the 2014 American Geophysical Union fall meeting in San Francisco, CA.

- P. Bieniek presented on his extreme events analysis based on Alaska station data at the fall American Geophysical Union meeting in San Francisco, CA.
- Findings on extreme events are being incorporated into assessment reports now being produced by Arctic Monitoring and Assessment Program (AMAP). Walsh is chapter lead for climate chapters in two ongoing AMAP reports.

2. Statistically Downscaled Climate Projections for Alaska

The following research findings and accomplishments have emerged from the collaborative downscaling activities involving **ACCAP, SNAP (Scenarios Network for Alaska and Arctic Planning)** and the **Department of Interior's Alaska Climate Science Center.**

Key Research Findings:

- Western and south-eastern Alaska show the greatest potential for marked changes from snow-dominated to mixed precipitation regimes, although these areas also exhibit a wide range of future conditions arising from the spread of climate model projections.
- Based on the rate of divergence of future scenarios of greenhouse gas and aerosol forcing, opportunities for human responses to future warming projected by global climate models can be distinguished by two phases: an adaptation phase through 2050-2060 and a mitigation phase from 2060 onward.
- Low-frequency variability corresponding to the Pacific decadal oscillation (PDO) includes Alaska's generally warm period of the 1920s and 1930s, a cold period from the late 1940s through the mid-1970s, a warm period from the late 1970s through the early 2000s, and a cooler period in the most recent decade. An exception to the cooling of the past decade is the North Slope climate division, which has continued to warm. There has been a gradual upward trend of Alaskan temperatures relative to the PDO since 1920, resulting in a statewide average warming of about 1°C (Bieniek et al., 2014).

Key accomplishments:

- ACCAP, in collaboration with **SNAP** and the **DOI Alaska Climate Science Center,** participated in the construction and evaluation of 771 m-resolution gridded historical and statistically downscaled projections of snow/rain partitioning for the state of Alaska at decadal temporal resolution.
- Regional climate model downscaling for Alaska, utilizing the WRF (Weather Research and Forecasting) model, has been undertaken in collaboration with the Alaska Climate Science Center. Simulations have been completed for the historical (1970-present) period and for one future (RCP 8.5 forcing) period (through 2100) driven by the Community Climate System Model (CCSM) under RCP 8.5 forcing.

Key outreach activities/presentations

- Presentations on dynamical downscaling were given by P. Bieniek at a workshops on North Pacific warm ocean temperatures (May 2015) and Alaska Climate Science Center annual review (March 2015).
- Walsh will give a presentation on downscaling techniques as an instructor at National Weather Service Advanced Workshop on Climate Variability and Climate Change (Kansas City, July 2015)

B. Sea Ice

Historical Sea Ice Atlas for Alaska Waters

ACCAP and **AOOS** are currently exploring the inclusion of sea ice information from Royal Dutch Shell Corporation into the digital atlas. Extension of digital sea ice database to pan-Arctic region has been undertaken in partnership with **National Snow and Ice Data Center** (F. Fetterer); primary users to date are NOAA Earth System Research Laboratory's 20th-Century Reanalysis project team and Hadley Centre's (U.K.) climate modeling group (N. Rayner).

The first of the Semi-annual updates to the Historical Sea Ice Atlas for Alaska was performed with a small amount of auxiliary funding from AOOS. Additionally, the Historical Sea Ice Atlas was included in the evaluation of three ACCAP tools that is currently underway. The information collected during the evaluation will drive future development on the Atlas. Development of user interface for pan-Arctic Atlas would be a feasible next step (http://seaiceatlas.snap.uaf.edu/).

Key Research Findings:

- Recent (post-2007) retreat of sea ice in Alaskan region is unique in the past 160 years
- When historical sea ice database is used as basis for climate model evaluation and selection, top-performing models project an earlier disappearance of summer Arctic sea ice (Rogers et al., 2014, *Polar Geography*).

Key accomplishments:

- Alaska digital sea ice atlas has been completed and updated through 2014.
- A pan-Arctic dataset sea ice dataset spanning the same timeframe as the Alaska atlas has been developed in digital form.
- User feedback on Alaska sea ice atlas has been obtained through ACCAP product evaluation (Goldstream Group).

Key outreach activities/presentations

- Walsh presented on the Alaska sea ice database at the National Center for Atmospheric Research (February 2015, Boulder, CO) and will present at the Navy's Symposium on Ice-Diminishing Arctic (July 2015, Washington, DC),
- Walsh presented on Alaska Sea Ice Atlas to the Fairbanks Rotary on April 6, 2015

C. Adaptation and Boundary Science

1. Social Network Analysis of Climate Science, Services and Application in Alaska.

This collaborative project with the **DOI Alaska Climate Science Center (AK CSC)** is mapping the landscape of climate science, services, and application in Alaska across a range of sectors and organizations. Thus far, ACCAP scientists (Kettle) have conducted 126 interviews with key individuals involved in climate-related research, services and decision-making in Alaska. Interview transcripts have been transcribed and are currently being analyzed to understand (A) the extent to which mutually exclusive categories of producers and consumers of information represents the diversity of actors and organizations involved in climate change decision-making and adaptation (B) how network structure relates to adaptive action. (https://accap.uaf.edu/node/595).

Key Research Findings:

- Conceptualizing the climate science-practice interface in terms of mutually exclusive categories of producers and consumers of information oversimplifies the roles of the diverse actors and organizations involved in climate change adaptation. Some individuals engage climate research, services, and application of climate information as discrete activities, while others will engage in multiple activities.
- Social network analysis is a useful heuristic for identifying patterns of information flow across Alaska. We anticipate emerging findings from this project to be useful in evaluating the extent ACCAP is embedded in the climate science-practice interface across Alaska, and in strategically identifying future ACCAP partners and steering committee members.

Key outreach activities/presentations

- Kettle presented **"**A social network analysis of climate research, services, and decision making in Alaska" at the joint LCC/CSC Climate, Conservation, and Community in Alaska and Northwest Canada Conference in Anchorage, AK, November 3-6, 2014.

2. Analysis of ACCAP Climate Webinar Series.

Building upon recent evaluations of ACCAPs ongoing climate webinar series in supporting knowledge to action networks for climate adaptation in Alaska (Trainor et al. 2014 – RISA Chapter in press), ACCAP examined how innovations in their boundary-spanning role improves outcomes through partnering with other boundary organizations. We utilized the concept of boundary chains to investigate outcomes associated with different extended network connections. (See section 6.A. for further details).

3. Evaluation: Three ACCAP Decision Support Tools

In early 2014 ACCAP contracted with the **Goldstream Group Inc**. (Angela Larson) in designing and implementing an evaluation of three ACCAP products: the Historical Sea Ice Atlas for Alaska Waters, the ACCAP Climate and Weather Highlights Tool, and the Alaska Climate Dispatch. The survey was conducted in the fall and early winter of 2014-15. We will use the results of this evaluation to measure success in creating useful decision support tools and to inform and refine future development of the tools, and to help inform future ACCAP activities. The evaluation is nearing completion and we anticipate the delivery of the final report by the end of June 2015. (See section 6.B. for further details)

D. Coastal and Living Marine Resources:

Public Perceptions of Ocean Acidification

In conjunction with the Ocean Acidification Research Center (OARC) at UAF and building on previous work done on an ocean acidification (OA) sensitivity index for Alaska (Mathis et al. 2014), ACCAP undertook research to better understand public perceptions in Alaska of OA, ocean health, and related research and policy. ACCAP conducted a mail-based survey to understand self-assessed knowledge and awareness of OA, perceived threats to Alaska fisheries, level of concern, and support for ocean-related research and policy. In conjunction with the OA Sensitivity Index, we are using the results of this work to determine gaps in public understanding of OA and to identify where and how to focus outreach and education initiatives. For example, ACCAP (Kettle) is collaborating with Alaska Sea Grant MAP agents to explore how to engage fishery and hatchery managers in Alaska in discussions about OA. Collectively, this information

will direct ACCAP and the **Ocean Acidification Research Center** on how to best communicate with communities and commercial fishing interests to prepare for future ocean changes. A paper summarizing these findings was published in *Marine Policy* (Frisch et al. 2015, https://accap.uaf.edu/node/963).

Key Research Findings:

- Alaskan residents believe they have a limited knowledge and awareness of OA.
- Participants with a higher level of self-assessed understanding of OA associate OA with human activity, but do not associate OA with natural variability.
- Among factors assessed, ocean acidification is the second greatest perceived threat to Alaska fisheries, only behind overfishing.
- Concern for OA increases from the near term (present to 10 years from now) to the future (50-100 years)

Key outreach activities and/or presentations

- Frisch presented at the Ocean Acidification in Alaska Workshop (December 2014) on public perceptions of ocean acidification.

3. GENERAL STAKEHOLDER OUTREACH ACTIVITIES

During this reporting period, ACCAP investigators presented their research, participated in panel discussions, hosted and attended workshops, and chaired sessions in a variety of venues, both within Alaska and on a national level:

- **Alaska**: Alaska Forum on the Environment, Western Alaska Interdisciplinary Science Conference, National Exercise Program (NEP) Alaska Climate Change Preparedness & Resilience Workshop, Climate, Conservation, and Community in Alaska and Northwest Canada joint LCC/CSC workshop.
- **National**: American Geophysical Union Fall Meeting, National Adaptation Forum, American Meteorological Society Symposium on Societal Applications, Climate Predictions and Application Workshop, Council of State Governments National Meeting.

Social Media. This year, ACCAP has seen an increase in social media influence, with 528 fans on Facebook (446 last year) and 238 followers on Twitter (178 last year). ACCAP's Facebook presence averaged a reach of 93 people per day during this reporting period with a maximum daily reach of 833 people during the incredibly warm May in 2015.

Newsletter. Published quarterly since 2010 and written for a non-technical audience, the *Alaska Climate Dispatch* (see sections 1.A, 6.B. and, appendix 2) includes seasonal weather and climate summaries, feature articles on topics of current interest, as well as Alaska weather, wildfire, and sea ice outlooks.

Webinars. ACCAP continues to host its monthly Alaska Climate Webinar Series, accessible to stakeholders directly and through a network of hub-viewing locations. Since 2007, ACCAP has hosted statewide climate webinars designed to promote dialogue between scientists and people who need information related to climate change in Alaska to make well-informed decisions (see section 6.A.).

More than 1028 people participated in ACCAP Alaska Climate webinars during this reporting period with a maximum single event participation of 180+ participants for the August 2014 "El Niño in Alaska: Past, Present, and Future" webinar presented by Rick Thoman of the NWS and Jon Gottschalck of NOAA Climate Prediction Center (CPC). ACCAP webinars draw a diverse audience, including representatives from the media, federal and state agencies, industry, and tribal groups, and are increasing used by federal collaborators as a cost-effective way to reach Alaska stakeholders. In addition to noted scientists from **UAF** and other universities across the country and Canada, and regionally based partners, ACCAP webinars this year featured scientists from federal partners including **NOAA CPC** and the **USGS Alaska Science Center, the Alaska Fire Science Consortium, Alaska Sea Grant** and the **National Ecological Observatory Network.**

In this reporting period ACCAP began a new webinar series in collaboration with NWS. The NWS Alaska Climate Forecast Briefing webinar series has had over 180 participants both in-person and online over the 12 briefings that occurred during this reporting period. The Briefing has also helped foster closer connections between the NWS and the Atmospheric Sciences Department at UAF (more details presented in section 1.A.).

4. STUDENT AND POST-DOC MATRICULATION AND RECRUITMENT

- Post-doctoral fellow, Nathan Kettle, continues to spearhead the boundary science and social network analysis.
- Post-doctoral fellow, Peter Bieniek, continues to conduct the climate science project, *Using Climate Divisions to Construct Anomalies and Trends in Alaska*. His work on climate divisions was made operational by the National Centers for Environmental Information (NCEI) in February 2015. Bieniek is also active in the dynamical downscaling project described earlier.
- Masters student Lauren Frisch completed her survey of perceptions of ocean acidification in Alaska and successfully defended her masters work at Bard College in New York State. She worked with ACCAP post-doctoral fellow Nathan Kettle to publish her findings and continues to work in the UAF Ocean Acidification Research Center.
- Interdisciplinary PhD student Katia Kontar joined ACCAP in May of 2015. Her work focuses on improve preparedness and response to annual springtime flooding in Alaska and Yakutia through the development of effective and easily adaptable flood risk mitigation and disaster response and recovery strategies.
- Rick Lader joined ACCAP as a PhD student in May of 2015. His work will include an assessment of extreme events in dynamical downscaling output for Alaska, based on regional climate model simulations.

5. NARRATIVES

A. U.S. Fish and Wildlife Service, Western Alaska Landscape Conservation Cooperative (WALCC)

The goal of this effort was to identify current coastal research and management projects that are taking place in Western Alaska and to synthesize information into a report that documents the 'project landscape' for communities facing change, decision-makers navigating change,

researchers pursuing projects, as well as funding agencies trying to prioritize where to allocate resources. To identify coastal change projects, we first conducted an extensive Internet search utilizing existing databases and online resources. We then contacted 130 stakeholders from a diverse range of university, state, federal, native and local institutions to review and comment on additional projects. We summarized the list of projects into key disciplines and topic areas. We then compared our list of current coastal projects to a list of key recommended needs identified from the 2012 Coastal Hazards Workshop (https://accap.uaf.edu/W_AK_LCC_Coastal_Change_Research).

Key Research Findings:

- The majority (38%) of current coastal change projects in Western Alaska are focused on biological system projects (e.g. fish, bird, habitat and marine mammal species).
- Human system projects (subsistence, local knowledge and coastal change adaptation) comprised 26% of the total number of projects occurring in the region.
- Landscape/Geophysical system projects (e.g. research that is related to geophysical processes along the coastline or near shore stretches of land) represented 20% of the total number of current efforts.
- Oceanographic system projects (projects related to ocean currents, waves, biochemical fluxes) had the fewest number of current projects (16% of the total number of projects),
- Only 32% of the projects were categorized as a "recommended need" based on knowledge gaps identified in a 2012 Coastal Hazards Workshop.

Key accomplishments

- Our final report provides a synthesis of current project efforts in Western Alaska that may help to (1) to foster better coordination about coastal studies in Western Alaska, (2) help practitioners and scholars learn from one another, and (3) identify information gaps that need to be addressed. The report is available at https://accap.uaf.edu/W_AK_LCC_Coastal_Change_Research.

Key outreach activities and/or presentations

- Brown delivered an oral Presentation at the Western Alaska Interdisciplinary Science Conference in Bethel, AK (2015).

B. ***Climate Divisions in Alaska.***

ACCAP continues to partner with the **NOAA National Weather Service** (Rick Thoman), the **NOAA Alaska Regional Climate Services Director** (James Partain) and the **UAF Department of Atmospheric Sciences** (Peter Bieniek) in the creation and use of Alaska climate divisions as the basis for an assessment of Alaska temperature and precipitation trends. Climate Divisions for Alaska were officially accepted and made operational by the National Centers for Environmental Information (NCEI) in February of 2015. URL: http://www.ncdc.noaa.gov/cag/ Climate divisions outline geographic regions with homogenous climate variability. Divisions are often used for addressing climate trends, drought and other seasonal/annual climate monitoring and prediction applications. Thirteen climate divisions were recently delineated for Alaska, potentially opening up new avenues of climate and prediction for the region.

Utilizing these new climate divisions in Alaska allows for the development of new climate products and services, as well as to new avenues of climate research. Immediate examples of the benefits would be establishing divisional-based seasonal forecasts. Divisions would also make climate analysis in Alaska more comparable with that in the Continental United States

(CONUS). Further benefits would be helping to identify the particularly data sparse regions for future placement of long-term climate monitoring stations. In addition to the operational benefits, establishing these divisions within NCEI demonstrates the importance of collaboration between climate research and Research-to-Operations practitioners and partners/end-users of NOAA products and services.

Key Research Findings:

- Long-term (1920-2012) monthly divisional anomalies of temperature display similar decadal variability to the Pacific Decadal Oscillation in all 13 Alaska climate divisions.
- Short-term trends are variable and linked to the decadal variability of temperature, however there is a long-term trend of increasing temperature superimposed on the decadal variability.
- Precipitation variability and trends are much less coherent than those for temperature.

C. *Climate Adaptation Planning for Alaska Native Communities*

ACCAP is collaborating with the Nome Eskimo Community (NEC) to develop a climate adaptation plan for the tribal organizations located in Nome, Alaska. This includes tribal members of NEC, Native Village of Solomon, Native Village of Council, and King Island Native Community. Our collaborative process includes the identification of key climate-related risks and vulnerabilities, discussion of goals and visions of success, and prioritization of adaptation strategies. For this partnership, ACCAP is facilitating stakeholder interaction, providing downscaled climate data, and evaluating the adaptation planning process. The NEC is building local capacity by developing a staff position dedicated to addressing climate issues, who will serve as the local coordinator for the project.

The goals for this project are to (1) build climate literacy amongst community members, including familiarity of both climate science and local knowledge; (2) provide a forum for Nome and surrounding villages to identify and discuss climate impacts of concern, goals and visions of success, and adaptation strategies; (3) develop a Nome Tribal Climate Adaptation Plan; (4) share information with other rural Alaskan communities and Native communities; (5) pilot a model process to build capacity within stakeholder groups by implementing a "train the trainer" framework. By this we mean training individuals who are then able to work with communities to build capacity within those communities to do this kind of adaptation work on a very localize scale. This model builds on the idea of boundary chains and knowledge-to-action networks in the sense that the capacity to do adaptation planning is being built through these chains and knowledge-to-action networks.

This partnership began in 2014 when NEC approached ACCAP to help provide the capacity to develop this strategic tribal adaptation plan. We have two grant applications submitted for this project (Bureau of Indian Affairs and NOAA Environmental Literacy Grant) and are seeking leveraged funds to complete this work. Our approach leverages existing climate information recently downscaled for Alaska by the Scenario Network for Alaska and Arctic Planning (SNAP) and in-kind support from the NEC.

6. OVERALL IMPACT NARRATIVES

A. *Analysis of ACCAP Climate Webinar Series.*

Building upon recent evaluations of ACCAPs ongoing climate webinar series in supporting knowledge to action networks for climate adaptation in Alaska (Trainor et al. 2014 – RISA Chapter, in press) and to begin to assess the impacts of ACCAP within Alaska, ACCAP utilized

the concept of boundary chains to investigate outcomes associated with different extended network connections formed via satellite hub sites (Kettle, N. and Trainor, S.F. 2015, accepted). Our evaluation was based on the analysis of three datasets, including interviews (2013) and two web-based questionnaires (2010 and 2013-2015). Findings from the evaluation reveal several ways that remote engagement via the ACCAP webinar series facilitates learning, decision application, and cross-level network building, and overcomes barriers associated with large geographic distances between communities. ACCAP partnered with other boundary organizations to establish satellite hub sites to facilitate in-person gatherings at remote locations, thereby increasing the number and diversity of participants served and supporting local networking within organizations, agencies, and communities (Figure 1). Leveraging complementary resources through the satellite hub sites provided mutual benefits for ACCAP and partnering boundary organizations. These findings advance our understanding of the value of remote engagement in supporting boundary spanning processes and how boundary organizations innovate their roles to build capacity and increase the usability of climate information.

Key outreach activities/presentations

- Kettle presented a talk titled **"**Climate webinars as a platform for supporting extended networks in Alaska" at the American Meteorological Society 10th Symposium on Societal Applications: Policy, Research and Practice in Phoenix, AZ (4-8 January 2015).
- Kettle presented a poster titled "The role of climate webinars in supporting boundary organization networks in Alaska" at the National Adaptation Forum in St. Louis, MO (12-14 May 2015).

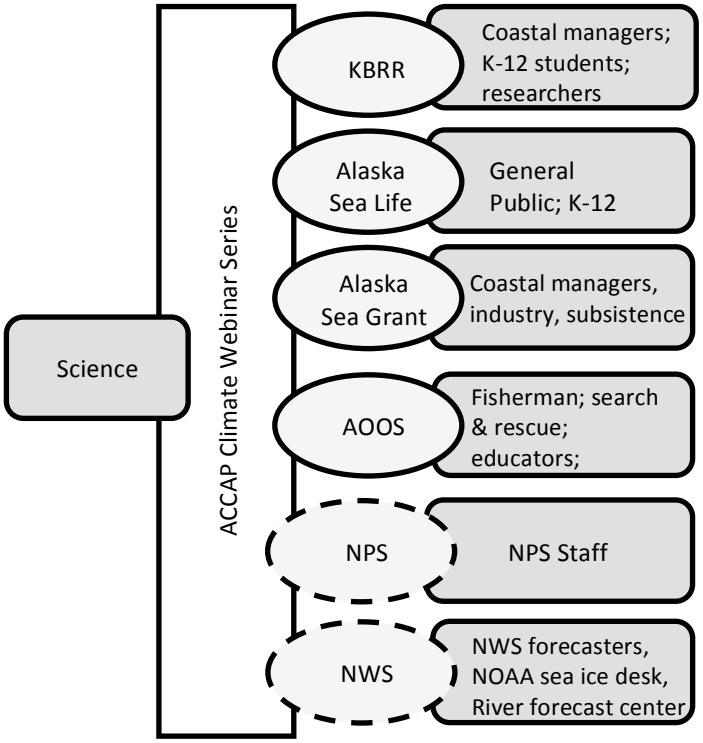

Figure 1: Examples of networking between ACCAP and other boundary organizations vis-a-vis the climate webinar series. Solid ovals represent formal satellite sites and the dashed ovals represent informal satellite sites. KBRR (Kachemak Bay National Estuarine Research Reserve); AOOS (Alaska Ocean Observing System); NPS (National Park Service); NWS (National Weather Service).

B. *Evaluation: Three ACCAP Decision Support Tools*

In 2014 ACCAP contracted with the **Goldstream Group Inc**. (Angela Larson) in designing and implementing an evaluation of three products: the Historical Sea Ice Atlas for Alaska Waters, the ACCAP Climate and Weather Highlights Tool, and the Alaska Climate Dispatch. The online survey was conducted from October 15, 2014 through December 2, 2014 via Survey Monkey. A total of 2,105 participants were invited to complete the survey, of those 296 completed for a response rate of 14%.

The purpose of this evaluation project was to describe user experiences with, and provide opportunities for improvement of, these decision support tools. The evaluation questions guiding the project are:

1. What are the characteristics of people who use the decision support tools?
2. Why do people use the decision support tools?
    a. What do people want to accomplish with the decision support tools?
3. How satisfied are people with the content of the decision support tools, and how can it be improved?
    a. Are they satisfied with the information generated by the tool?
    b. Are they satisfied with the tool's data quality?
    c. Are they satisfied with the tool's data documentation?
4. How satisfied are people with the user interface, and how can it be improved?

In addition to addressing the evaluation questions, the results also include information on access, learning, sharing, and suggestions for each level of familiarity and use for each tool.

For all three ACCAP decision support tools we found consistent results. Those who use the tools are mostly satisfied with them and use them regularly when the content is connected to their own work or for general and personal interests. Demographics of users are similar. For those who are non-users of the tools, they tend to not use them because they didn't know about them or because the content is not connected to their own work. Most learned about access to each of the tools through the ACCAP website or list serve. Most respondents identified at least a little learning concerning the topic of interest, with very few stating they learned nothing at all. Lastly, referrals are made most by those who use the tools to access data rather than just information.

Below we summaries the primary use for each of the three tools. The results show the different ways each tool is being used. This information provides useful guidance towards increasing ACCAP's impact within Alaska.

Historical Sea Ice Atlas

People primarily use the Historical Sea Ice Atlas for research, general information, and personal information. They approach the data from a wide variety of fields including natural resources, wildlife, local and cultural activities, engineering, transportation, emergency response, and health. They tend to access it either annually or monthly depending on the data and applications of interest. Often a single respondent used the tool in several ways as in the following:

"I have used it to field information requests from policy-makers and stakeholders at the federal, state and local levels with regards to how sea ice extents have impacted coastal erosion and coastal flooding in Alaska. I have used it as a research tool to extract location-specific sea ice extents for use in the preparation of scientific manuscripts. I have also used it as a teaching tool both in and outside of the classroom."

Table 1: Historical Sea Ice Atlas Use*·

What do you use the Historical Sea Ice Atlas for? Please select all that apply.				
	USERS		DABBLERS	
	Count	Frequency	Count	Frequency
Policy-making	4	23.5%	3	3.2%
Decision support	7	41.2%	12	12.6%
Management	2	11.8%	6	6.3%
Research	11	64.7%	37	38.9%
General information	10	58.8%	56	58.9%
Personal interest	7	41.2%	50	52.6%
Other (please specify)	0	0.0%	6	6.3%

Alaska Climate and Weather Highlights Tool

People primarily use the Alaska Climate and Weather Highlights for personal information, general information, and research. They tend to access it either yearly or monthly, depending on the data and applications of interest. Thirty-six percent mentioned using the tool in their work, for example:

"We highlight the information gleaned from this site in resource briefs for NPS park management and superintendents. It also provides a great overall summary of weather/climate conditions on multiple scales. We often compare information from this site to data we are gathering from park sites."

"Writing EIS/EA docs and general knowledge for decision making"

Table 2: Alaska Climate and Weather Highlights Tool Use*

What do you use the Alaska Climate and Weather Highlights tool for? Please select all that apply.				
	USERS		DABBLERS	
	Count	Frequency	Count	Frequency
Policy-making	1	4.3%	6	7.9%
Decision support	5	21.7%	12	15.8%
Management	2	8.7%	9	11.8%
Research	14	60.9%	28	36.8%
General information	18	78.3%	44	57.9%
Personal interest	17	73.9%	40	52.6%
Other (please specify)	2	8.7%	3	3.9%

· *Respondents could select more than one use leading to total frequency of use greater than 100%.*

Alaska Climate Dispatch

People primarily use the Alaska Climate Dispatch for general information, personal information and research. They tend to access it quarterly for information. One example of use expressed was:

> *"I use it to keep me informed about the bigger picture of climate and weather events in Alaska. It is the go-to reading for getting a complete summary of the most recent season. It helps us understand local and regional climate patterns in the parks and also puts local weather and climate in context."*

Table 3: Alaska Climate Dispatch Use*

What do you use the Alaska Climate Dispatch for? Please select all that apply.		
	USERS & DABBLERS	
	Count	Frequency
Policy-making	3	3.7%
Decision support	11	13.6%
Management	7	8.6%
Research	26	32.1%
General information	63	77.8%
Personal interest	49	60.5%
Other (please specify)	5	6.2%

Perhaps the most insight into understanding usage and satisfaction of the three weather and climate tools is found in the open-ended responses summarized throughout the report. Although few in number compared to the total dataset the responses provide details into the work that users do and how each tool can benefit or support them. They also identified what they liked best about each tool and provided suggestions for improvements that range from "easily implemented" to "perhaps not possible." Finally, awareness may be the predominant reason for the few number of users, supporting the need to spread the word to those who are likely to use the tools to increase usage (full report will be available in July 2015).

7. HIGHLIGHTED PUBLICATIONS, WHITE PAPERS, & REPORTS

Journal Articles

Bennett, K.E., and **J. E. Walsh** (2014). Spatial and temporal changes in indices of extreme precipitation and temperature for Alaska. *Int. J. Climatol*., doi::10.1002/joc.4067.

Bieniek, P.A., J. E. Walsh, R.L. Thoman and U.S. Bhatt (2014). Using climate divisions to analyze variations and trends in Alaska temperature and precipitation. *J. Climate, 27*, 2800-2818.

Frisch, L. **J. Mathis**, **N. Kettle**, and **S. Trainor**. 2015. Gauging perceptions of ocean acidification in Alaska. *Marine Policy.* 53:101-110.

Kettle, N.P. and **S.F. Trainor**. (Accepted) The role of remote engagement in supporting boundary chain networks across Alaska. *Climate Risk Management*.

Knapp, C. & Trainor, S.F. (2015): Alaskan stakeholder-defined research needs in the context of climate change, .*Polar Geography.*

Lader, R., U. S. Bhatt, **J. E. Walsh, T. S. Rupp and P. A. Bieniek**, (2015): Atmospheric reanalysis products evaluated for Alaska to facilitate climate impact studies. *J. Clim. Appl. Meteor*., submitted June 2015.

J.T. Mathis, S.R. Cooley, N. Lucey, S. Colt, J. Ekstrom, T. Hurst, C. Hauri, W. Evans, J.N. Cross, R.A. Feely. Ocean acidification risk assessment for Alaska's fishery sector. *Progress in Oceanography*, Available online 18 July 2014, ISSN 0079-6611

Book Chapters
Trainor S. F., N. Kettle, J.B. Gamble (In press). Not Another Webinar! Regional Webinars as a Platform for Climate Knowledge to Action Networking in Alaska. In Climate in Context, eds. A. Parris and G. Garffin. Wiley & Sons.

Technical Report:
The Arctic Council, Adaptation Actions for A Changing Arctic Report, Bering, Chukchi, Beaufort Region. **J.Walsh and S.Trainor** contributing lead authors. [Expected publication, Dec. 2016.]

White Papers & Newsletters
Walsh, J.E., and A. York (eds). Alaska Climate Dispatch Quarterly Newsletter. (https://accap.uaf.edu/library/dispatches)

8. ATTACHMENTS/APPENDICES

(All attachments have been optimized and placed in one PDF for digital delivery. Please request higher resolution files for print.)

1. Alaska Climate Dispatch (June 2014, Combined September - December 2014, March 2015)

2. Peer – reviewed journal publications listed above.